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AN EXPERIMENTAL STUDY OF SEQUENCING STRATEGIES.

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TWO STRATEGIES FOR TEACHING MULTIPLE-DISCRIMINATION TASKS WERE REPORTED. THE "MULTIPLE CONCEPT" PRESENTS SIMPLE DESCRIPTIONS OF SEVERAL RELATED CONCEPTS AT THE BEGINNING OF INSTRUCTION. INCREASINGLY COMPLEX MATERIAL PERTAINING TO THESE CONCEPTS IS THEN GRADUALLY INTRODUCED. THE "SINGLE CONCEPT" PRESENTS ONE CONCEPT AT A TIME, PROCEEDING FROM SIMPLE TO MORE COMPLEX DESCRIPTIONS OF THE SAME CONCEPT. THIS STEP IS THEN REPEATED TO DESCRIBE SUBSEQUENT CONCEPTS. TWO SETS OF INSTRUCTIONAL MATERIALS WERE PREPARED FOR FIFTH-GRADE STUDENTS--(1) SCIENCE MATERIALS FOR PRESENTATION TO GROUPS AT A FIXED PACE AS SLIDE-TAPE LESSONS AND (2) LANGUAGE ARTS MATERIALS FOR INDIVIDUALLY PACED PRESENTATION IN PROGRAMED TEXTBOOKS. TWO SEQUENCES WERE PREPARED FOR EACH LESSON SET FOLLOWING THE STRATEGIES DESCRIBED. SET VERSIONS CONTAINED THE SAME INSTRUCTIONAL ITEMS AND REQUIRED THE SAME STUDENT RESPONSES, ONLY THE SEQUENCE OF ITEMS WAS CHANGED. THE MULTIPLE CONCEPT SEQUENCE PRODUCED CONSISTENTLY BETTER STUDENT PERFORMANCE. THE DIFFERENCES BETWEEN GROUPS ON POST-TESTS AND RETENTION TESTS WERE SIGNIFICANT AT THE .01 LEVEL FOR THE SCIENCE LESSONS, BUT NOT SIGNIFICANT FOR THE LANGUAGE ARTS LESSONS. (GC)

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December 1966

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HEALTH, EDUCATION, AND WELFARE
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AMERICAN INSTITUTES FOR RESEARCH
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Betty E. Haughey

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INTRODUCTION

"What should I teach first?" . . . "What is the best way to sequence this lesson?" . . . "Do I arrange the lesson in a logical outline?" . . . "What sequence will help students learn best?" . . . "Should I develop one point in detail before I go on to the next point, or should I first talk about all of the points at a simple level?"

These are questions that teachers have asked while preparing their first self-instructional programs. The questions are probably typical of those an instructor asks himself before preparing a lesson for any of the new instructional media such as television, films, programmed instruction, or audio-tape recordings. Decisions about sequencing strategies seem particularly important for these media because once a lesson is programmed, filmed, or taped, the sequence of instruction within the lesson is fixed and repeated again and again in later presentations.

It seems reasonable to expect that the sequence of instruction in a lesson will influence the lesson's effectiveness. However, there are few, if any, experimentally validated guidelines to aid instructors in choosing among alternate sequencing strategies. Even very simple questions about sequencing are difficult to answer with experimental evidence. Carroll (1) has noted this difficulty with respect to programmed instruction:

> "My own preference would be for a type of programming in which attention would be cycled successively through some number of facts greater than one, rather than massing attention on one fact at a time. Unfortunately, it is difficult to cite psychological experimentation that would clearly help one to decide between these procedures. There are indeed curious gaps in our knowledge of the learning processes."

The purpose of the project described in this report was to compare two contrasting sequencing strategies: a single-concept strategy and a multiple-concept strategy. The comparison was replicated by applying the two strategies to different subject matters and different media. In this way, the study was designed to detect reliable generalizations about sequencing that would help instructors prepare lessons in various media and subject matter areas, and that would apply whether the instructors were preparing math programs, biology films, language tapes, or TV science lessons.

Related Research

Many texts and articles about programmed instruction have emphasized the importance of careful sequencing, but experimental studies have failed to demonstrate that sequencing has a consistent effect on learning. Most of these studies have compared an author's own sequence of programmed items with a random sequence of the same items. Gavurin and Donahue (5) found that students took longer to reach a criterion of a no-error trial on a programmed unit when items within the unit were presented in a random sequence rather than in the original, planned sequence. On the other hand, Roe, et al. (13), Roe (12), and Levin and Baker (10) found no significant difference in criterion test performance for groups that worked programs arranged in the authors' planned sequences and groups that worked randomly-sequenced versions of the same programs.

In these studies, the random sequence was to represent a poor sequencing condition; the authors' planned sequence was to represent an optimum sequencing condition. This type of experimental design can only determine whether a particular author's sequence of instruction is more effective than a random sequence. Since the author's sequence is usually not described in general terms, the results of these studies, even if positive, could not be used as guides for preparing lessons designed to teach different subject matters. There is also no apparent reason to consider a *random sequence* as synonymous with a *bad sequence*. Indeed, for some tasks, a random sequence may approximate an optimum sequencing strategy because it allows the student to practice making many discriminations under conditions of minimal cuing.

An alternate experimental design was used in the present study to develop and evaluate two sequencing strategies: the strategies were specified in generalized content-free terms so that they could be applied to different subject matters and different educational media. The two strategies were evaluated by comparing them to each other, rather than by comparing them to a random sequence.

A somewhat similar type of experimental design was used by Hickey and Newton (7). They described two general dimensions along which model sequencing strategies may vary: elemental-to-complex and specific-to-general. They then constructed twelve versions of a short economics program. However, they did not describe the twelve sequencing strategies in terms of the general model, but rather in terms of the order, position, and placement of specific subject-matter concepts. Therefore, it would be difficult to use their findings to construct lessons in other subject matters.

Reynolds and Glaser (11) also evaluated two general sequencing strategies. Their two strategies, "spiral" and "linear," are quite similar to the two strategies used in the present study. They found the two strategies did not differ in effectiveness. However, they applied the strategies to the sequencing of large units of relatively unrelated concepts in an attempt to vary review conditions. Thus, their "spiral sequence" was actually a sequence that emphasized review of previously presented material which contained many more frames than their linear sequence.

The Relationship Between Sequencing Strategies and Learning Tasks

An underlying assumption of the present study is that sequencing is an instructional variable that interacts with the type of behavior to be learned. It is assumed that an optimum sequence for teaching one type of behavior is different from the optimum sequence for teaching another type of behavior. For example, the best strategy for teaching a multiple discrimination is probably different from the best strategy for teaching a procedural chain. No attempt was made in the study to complete a comprehensive matrix identifying all classes of behavior and their corresponding optimum sequencing strategies. Rather, the aim of the project was to describe one cell of this matrix, namely the cell identifying the better sequencing strategy for teaching multiple discrimination behavior.

In learning a multiple discrimination, a student learns to make different responses to similar stimuli that previously evoked an undifferentiated response. The simplest form of a multiple-discrimination task has been described by Gagné (4) in this way:

> "The student may learn to distinguish among stimuli of different physical appearance. A young child having a set of leaves on his desk may learn to distinguish them by means of the verbal labels 'elm,' 'maple,' 'oak,' 'poplar,' and so forth. A student of astronomy learns to identify certain stars and certain constellations. He distinguishes them, one from the other, by giving them different names. . . ."

A learning task which contains a major multiple-discrimination element can usually be identified by examining the set of physical stimuli or verbal concepts to which the student must respond. If these appear similar to the naive student but different to the trained expert, the major objective of training is to teach the student to discriminate among the concepts and make the appropriate differentiated response to each one.

Description of the Two Sequencing Strategies

The two sequencing strategies used in this study represent rational or often used alternatives for teaching multiple-discrimination behavior. The first strategy, which was derived from a recommendation by Gilbert (6), emphasizes continual discrimination among related concepts. This sequence, which is identified in this report as the *multiple-concept sequence*, introduces all of the related concepts at a simple level and then proceeds to more complex and detailed levels, always dealing with all of the concepts at each level. The second strategy emphasizes detailed instruction and mastery of a single concept before a new concept is introduced. This sequence, the *single-concept sequence*, treats each concept in detail before presenting the next concept.

An illustration of the two sequences is shown in Figure 1. The objective of this illustrative lesson would be to teach students to discriminate between the concepts of "latitude" and "longitude" in terms of various types of responses.

In the *multiple-concept* sequencing strategy, the contrasting aspects of both latitude and longitude would be presented simultaneously. The instructional materials would be sequenced so that the contents of the matrix cells in Figure 1 would be taught in this order: 1 & 5, 2 & 6, 3 & 7, 4 & 8. Thus the student would always be dealing with some characteristic of both longitude and latitude at each step in the lesson. In the *single-concept* strategy, all of the detail and complexities of one concept would be taught before the second concept was introduced. The instructional materials would be sequenced so that the contents of the matrix cells in Figure 1 would be taught in this order: 1-2-3-4, 5-6-7-8.

The single-concept sequence is frequently found in textbooks and instructional presentations. For example, exercises in English grammar texts are often organized around a single type of error. Thus, students are given extensive practice in correcting one type of error at a time. Since all of the sentences in a typical exercise are usually incorrect and all of them are incorrect in the same way, the students get no practice in discriminating incorrect sentences from correct ones nor in discriminating sentences requiring one type of correction from those requiring another type. Indeed, the single-concept sequence is the natural presentation sequence for many authors and instructors. It appears to be more orderly to develop a concept in some detail before introducing other concepts either related to it or easily confused with it. Often concepts are presented individually and a student must work out his own comparisons and contrasts.

MAJOR CONCEPTS	ELEMENTS OF CONCEPTS			
Latitude	1. Horizontal lines on a Mercator projection map	2. Measured North and South of the equator	3. Measured from 0°-90°	4. Each minute equals approximately one nautical mile
Longitude	5. Vertical lines on a Mercator projection map	6. Measured East and West of the Prime Meridian	7. Measured from 0°-180°	8. Length of each minute varies with latitude

Sequence	Concepts arranged in this order
Multiple concept sequence:	1, 5, 2, 6, 3, 7, 4, 8
Single concept sequence:	1, 2, 3, 4, 5, 6, 7, 8

Fig. 1. Illustration of two sequencing strategies for teaching the concepts of latitude and longitude.

The contrasting approach, the multiple-concept sequence, has been described by Gilbert (6):

> "The fifth rule [for sequencing], that the entire multiple is best established in one exercise [one page], is dictated by the nature of a multiple discrimination. In a multiple, we have not only to establish the strength of several separate operants, but we must prevent each response from coming under control of the other stimuli in the multiple."

This multiple-concept sequencing strategy also has strong experimental support from operant-conditioning studies. The standard experimental procedure for teaching an animal to make a discrimination between two stimuli is to present both stimuli simultaneously or interspersed in a random sequence and to reinforce responses to one stimuli and extinguish responses to the other stimuli. Terrace (15) has demonstrated a modification of this procedure in which animals learn to make fine discriminations between quite similar stimuli without ever making errors during instruction.

Thus, both the single-concept and the multiple-concept sequencing strategies have been used to teach multiple discrimination behavior. In the present study, the effectiveness and efficiency of the two sequencing strategies were evaluated by preparing two lessons, each in a different subject area. Each lesson was developed for presentation in a different media. One media presentation permitted individual pacing; the other was administered to a group at a fixed pace.

Each lesson was prepared in a single-concept and a multiple-concept sequence, and the effectiveness of these two versions of the lesson was compared. In each version of a lesson, only the sequence of instruction was changed. All the other variables such as the instructional stimuli and the required responses were held constant. In this way, it was hoped that the study would differentiate between the effectiveness of the two strategies and make it possible to recommend one of them to instructors teaching multiple discriminations in various subject matters and media.

Method

Pilot Study

In order to work out procedures for developing the instructional materials, a pilot program was prepared to teach an artificial multiple discrimination task. The task consisted of interpreting the meaning of display patterns on a fictitious control panel. Figure 2, which shows a few frames of the pilot program, illustrates the nature of the task.

In the single-concept version of the program, Ss first learned to identify all the "go" patterns, both simple and complex. They then learned the "hold" patterns and then the "cancel" patterns. In the multiple-concept version, Ss first learned the simplest stimulus patterns associated with all three responses, and then learned the more complex patterns associated with all three responses.

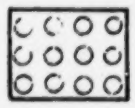
In developing the pilot program, techniques were worked out to prepare independent program items which could be rearranged to implement the two sequencing strategies without requiring any change in the stimulus content or response requirements of the two versions. It was possible to prepare two programs that differed only in sequence, i.e., only in the time when a student saw a particular stimulus and made a particular response. In all other respects, both versions were identical.

The two sequences were administered to 22 teachers and school administrators who were taking part in a summer programming workshop. Each S was randomly assigned to one of the two lesson versions. The results of the pilot study are shown in Table 1. The group learning from the multiple-concept sequence scored about 20% higher on an immediate posttest. ($t = 1.74$, $df = 20$, $p < .05$)

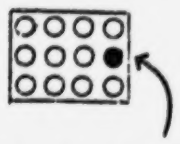
Table 1

Posttest Performance on Pilot Program

SEQUENCE	Mean	SD	N	% Correct
SINGLE CONCEPT	18.5	5.1	12	60%
MULTIPLE CONCEPT	22.2	4.9	10	72%

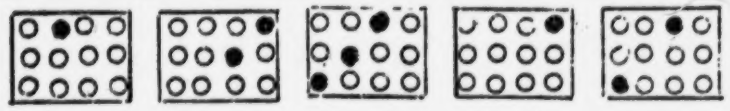


The 12 lights on this panel can be lit in different patterns to signal if a rocket firing should GO, HOLD, or CANCEL. In this program, you will learn to identify the light patterns that mean _____, _____, or _____.

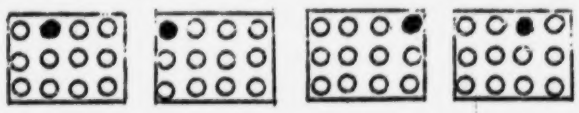


At this time, one light is lit on the panel. As far as you know now, this light could mean either _____, _____, or _____.

By the end of the program you will know exactly which of these conditions it means.



As you can see, sometimes only _____ light is lit on the panel, but often _____ lights are lit. Although these five panels have different light patterns, they all indicate the same condition: _____.



Each of these panels means GO. Whenever you see a single light in the _____ row of a panel, you know it means _____.

Fig. 2. Sample frames from the pilot program.

The results of the pilot study indicated that the two sequences, as implemented in the pilot study, were capable of yielding differential results--at least in teaching an artificial multiple discrimination task. Thus, it seemed worthwhile to apply the two strategies to actual instructional objectives, to material having more meaningful content, and to different media.

Preparation of the Experimental Lessons

Two sets of experimental lessons were prepared:

1. Science slide-tape presentation. The objectives of these lessons were to teach fifth-grade students (a) to classify vertebrates as fish, amphibians, reptiles, birds, and mammals; (b) to describe the characteristics of each of these classes; (c) to classify birds by their beaks and feet; and (d) to infer from these characteristics a bird's feeding habits and preferred environment. Since the lessons required the students to classify and describe a large number of animals by their observable characteristics, it seemed appropriate to use slides to show the animals. An audio-taped narration accompanied each slide. Since it was essential that a description or explanation of each slide be presented simultaneously with the slide, a recorded narration was used rather than a printed text. This procedure also reduced performance variability associated with different reading speeds and reading abilities. The lessons were presented to groups of students at a standard fixed pace.

2. Language arts programmed text presentation. The objective of one of the language arts lessons was to teach fifth-grade students to discriminate *run-on sentences* and *sentence fragments* from *correct sentences*, and then to improve run-on sentences and fragments. A second lesson taught students to recognize, define, and use five new vocabulary words. Since the stimulus materials for these lessons were all verbal, a printed programmed text was prepared. Each student worked through the program at his own pace.

Development of the science slide-tape presentation. Matrices of lesson objectives were prepared for each lesson. These are included in Appendix A. The matrix for the first lesson listed the various classes of animals and the various responses students should be able to make about each class, e.g., the characteristics of a class such as its reproductive process, body covering, temperature, breathing mechanism, etc. Appropriate slides and instructional narration were prepared for each cell of the matrix. For example, slides and narration were prepared to teach students

to describe how an amphibian's body temperature responds to outside changes in temperature. The material for each lesson was then arranged in the single-concept sequence and given to small groups of students in tryout sessions.

As a result of the tryouts, the format of the slide-tape presentation was radically changed. Initially, the presentation was entirely narrative and did not require students to make any responses. Because the lesson was ineffective in this form, the narration was changed to require students to respond aloud whenever they heard a response signal on the tape. After a pause, they heard the correct answer from the tape. This procedure was not much more effective than the no-response procedure. Even in small groups of four students, three students tended to "follow the leader" and simply echo his response rather than respond independently to the slide and narration. On the third tryout, group responding was completely eliminated, and each student was given a notebook in which to record his own response to each slide. The tryouts were also used to collect response time data. During the early tryouts the tape recorder was stopped for each response and response times were recorded. On the final tape, pauses based on the average response times were incorporated into the tape.

The change in response requirements--from no-response requirement, to group responding, and then to individual responding--seemed to produce a striking change in student performance. Since other aspects of the lessons were revised after each tryout, the observed changes in student performance cannot be attributed solely to the change in response requirements. However, it appeared that students were much more attentive during the lesson and performed much better on the posttest when individual responses were required.

Most of the tryouts were conducted on the single-concept sequence in order to assure that the items for a particular concept produced acceptable performance on the criterion item for that concept. During the last tryout, two students worked both the sequences to make sure the slides, narration, and response notebooks had been correctly arranged. The final version of the science slide-tape lesson required about 100 minutes to administer and contained 172 slides.

The same slides, narration, and response notebooks were used for both the multiple-concept and the single-concept sequences. Figure 3 illustrates how slides and narration were combined to form the different sequences. In the middle of Figure 3 is the slide and narration that occurred as Item 10 in the multiple-concept sequence and Item 38 in the single-concept version. In the multiple-concept sequence, illustrated by the three vertical

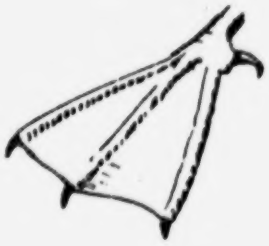
items in Figure 3, the student learned to develop his skills in identifying, naming, and drawing one type of foot. All of the items shown in Figure 3 appeared in both sequences, but at different points in the presentation depending on the sequencing strategy used. Figure 4 shows the items from a student notebook that accompanied the slides and narrations in Figure 3. Most of the responses could be made quickly and required a student either to circle the proper word, choose the correct drawing, trace a picture, or add to a drawing.

Development of the language arts program. Matrices were developed for the language arts lessons (Appendix A) and program frames were developed for each cell of the matrix. The five words taught in the vocabulary section were: *debris, hypocrite, initial, obsolete,* and *perseverance.* These words are listed in the Children's Knowledge of Words (2) as being unfamiliar to fourth-grade students but familiar to sixth-grade students. Students were taught to identify the meaning of a word, to pronounce it, to spell it, to define it, to recognize its correct usage, and to use it correctly in their own sentences.

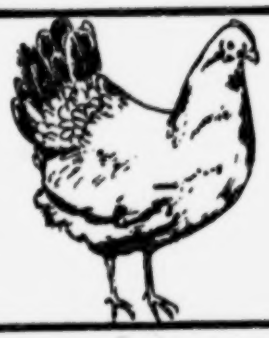
In the single-concept version, students learned to perform all these tasks with one word before going on to the next word. In the multiple-concept sequence, they learned to identify the meaning of all five words before going on to learn to pronounce all of them, spell all of them, etc. Figure 5 and Figure 6 show the first five frames in the single-concept and multiple-concept sequence. As in the science lessons, the identical frames appeared in each sequence and only the order of the presentation was different.

The sentence editing program taught students to recognize and correct six types of sentence errors. The errors were selected by analyzing 150 fifth-grade compositions. The most common errors in these papers were *sentence fragments* and *run-on sentences.* Each of these major categories were broken down into specific errors. Sentence fragments were classified as: *no subject; no verb;* and *phrase.* Run-on sentences were divided into: *several sentences connected by "and" or "and then;" several sentences joined by commas;* and *several sentences with no punctuation separating parts.* Basically the same type of programming technique was used as in the vocabulary unit. Students first learned to identify poor sentences, then to classify them as either "run-on" or "fragment," and finally to change them to make them into good sentences.

In the single-concept sequence of the sentence program, students learned to identify and correct one type of sentence error before proceeding to the second type of error. In the multiple-concept sequence, students learned to identify all types of sentence errors before learning how to correct these errors.



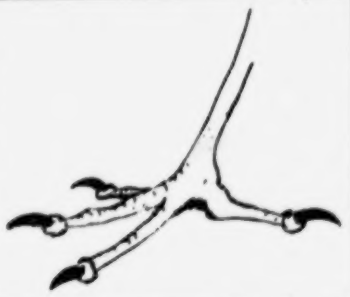
Narration: Turn to question 9. Circle what type of foot this is. (Pause) You should have circled the swimming foot. Now trace this swimming foot. Notice the webbing between the three front toes.



Narration: Turn to question 37. This is a different type of foot. Notice that the back toe is just a spur high on the leg. Circle the type and name of this foot. (Pause) You should have circled drawing number four and walking.

Narration: Turn to question (10) (38). Circle the type of foot. You should have circled walking. Now trace this walking bird's foot. Notice that the font is strong for walking on the ground. See that his back toe is very, very small.

Narration: Turn to question 39. What is missing from this walking bird's foot? Add it to the drawing. (Pause) You should have added a short back toe. Circle the type of bird that has this type of foot. (Pause) You should have circled the chicken.



Narration: Turn to question 11. Circle what type of foot this is. (Pause) You should have circled perching. Trace this perching font. See that all four toes are about the same length. Be sure to trace that long back toe; it helps the perching bird to hold on to limbs.

Fig. 3. Slides and narration from the science presentation illustrating the two sequencing strategies. Horizontal arrangement: single-concept sequence; vertical arrangement: multiple-concept sequence. See Figure 4 for the items from the student notebook that accompanied these slides and narration.

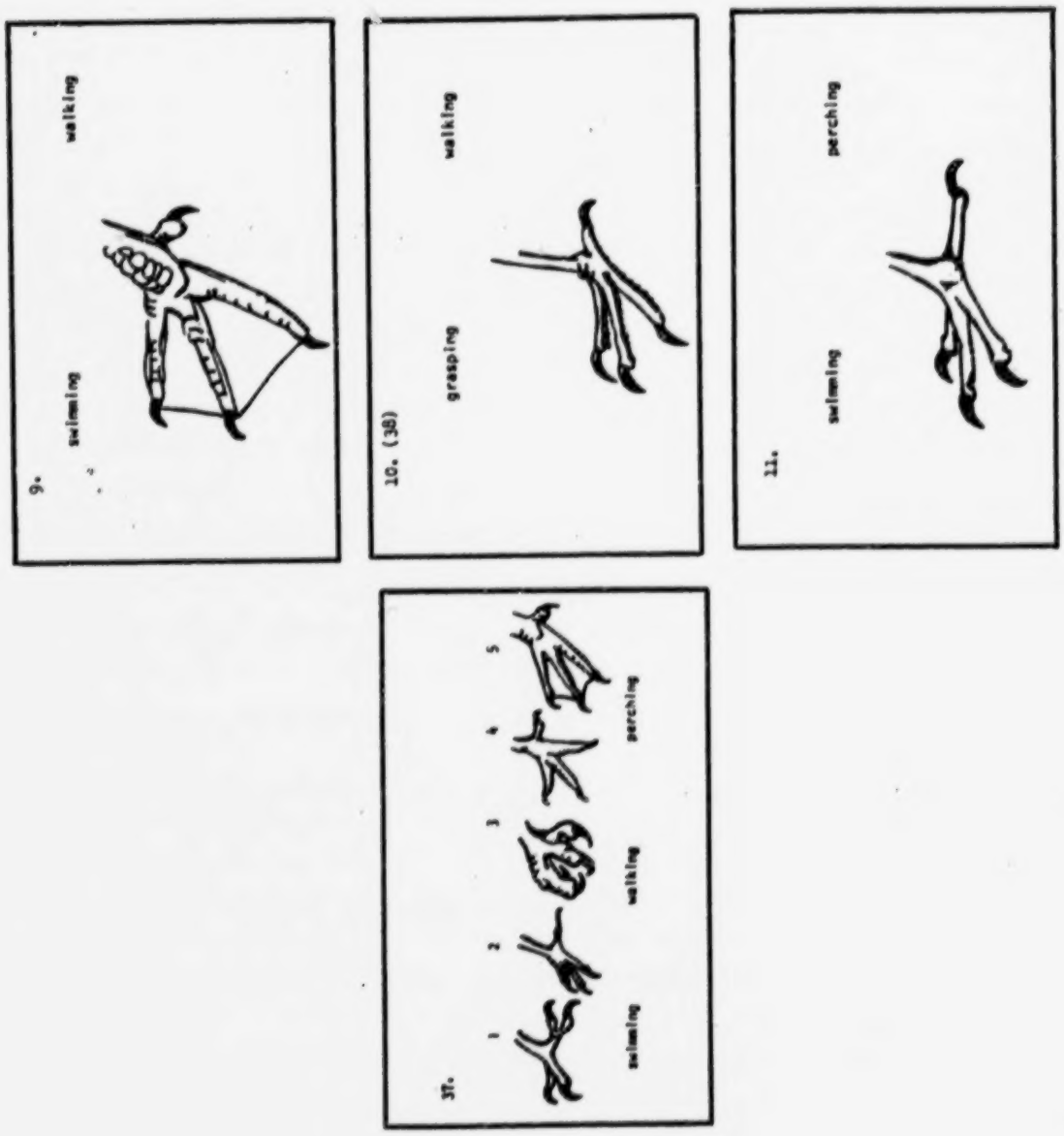
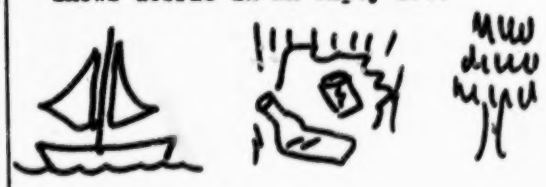


Fig. 4. Items from student notebook that accompanied slides and narration shown in Fig. 3.

1.

Read this new word: DEBRIS.

Draw a circle around the picture that shows debris in an empty lot.



Turn the page to check your answer.

2.

The children found that the old house was filled with debris.

Inside the house they found many (check one)

___flowers and plants

___old newspapers and rags

___mice and rats

3.

When the building exploded, the streets were soon covered with debris.

This means

___Things in the street were exploding.

___Fire engines and police cars were in the streets.

___Broken and burned parts of the building were in the streets.

4.

A. B. C.

Which one of these containers do you think has debris in it? _____ A/B/C

(Write the correct letter in the blank)

5.

Debris is pronounced DUH-BREE.
Say it to yourself several times.

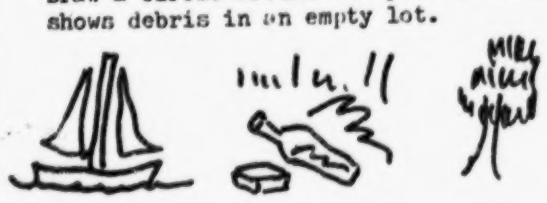
The accent is on the _____ first/second syllable.

Fig. 5. Initial frames from the vocabulary program arranged in the single-concept sequence.

1.

Read this new word : DEBRIS.

Draw a circle around the picture that shows debris in an empty lot.



Turn the page to check your answer.

2.

Here is another new word : HYPOCRITE.

Circle the picture of the person who is a hypocrite.

3.

Here is another new word : INITIAL.

Circle the initial number.

3751

4.

Here's another new word : OBSOLETE.

Circle the obsolete car.

5.

Another new word : PERSEVERANCE.

Circle the hill that would require the most perseverance to climb.

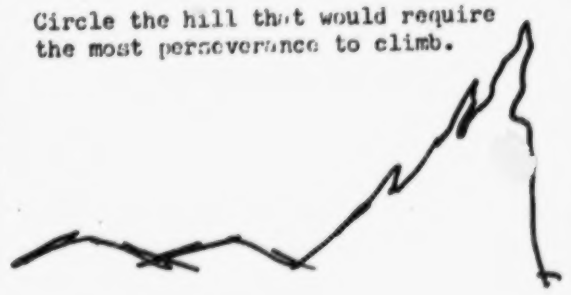


Fig. 6. Initial frames from the vocabulary program arranged in the multiple-concept sequence.

The single-concept version of the language arts lessons was given to tryout Ss and revised on the basis of these tryouts. In final form, the program contained 178 frames.

Introductory overview for all lessons. One possible advantage of the multiple-concept sequence is that students quickly learn what an entire lesson is about. For example, they might learn in the first few minutes of the presentation that the science lesson is about fish, amphibians, reptiles, birds, and mammals, rather than just about fish. Thus the sequence itself may provide an overview of the lesson. Since most instruction begins with some sort of overview, it seemed desirable to control this particular sequencing effect. Therefore, an introduction was prepared for each lesson to familiarize the students with the objectives of the complete lesson. For example, in the science program, twelve slides were devoted to an overview of biological classification. Students were told they were to learn the characteristics of all five classes of vertebrates and responded by writing the names of all the classes in their notebooks. This same introduction preceded both sequences.

Development of the criterion tests. Tests for each lesson were prepared before the lesson itself was written. Each test had two sections: a discrimination section, and a short essay section. The discrimination section required students to discriminate among all the concepts. The short essay section required students to summarize everything they had learned about each of the concepts. The tests were constructed in this way in order to fairly assess the effectiveness of both sequences. For example, in the first section of the science test, students first had to identify the class or characteristics of a number of different animals shown in drawings. In the second part of the test, students had to summarize all of the characteristics of a single class of vertebrates. Copies of all the criterion tests are included in Appendix B. Each criterion test was administered as a pretest, posttest and retention test.

The Experimental Evaluation

Design of the study. The *science slide-tape presentation* and the *language arts programmed text* were arranged in two sequences: *a single-concept sequence* and a *multiple-concept sequence*. The stimulus presentation and response requirements in each sequence were identical and only the sequence itself varied from one experimental condition to the other. Figure 7 illustrates the experimental design. The comparisons of interest, which are indicated by the arrows in the figure, are the comparisons *between the two sequences* within each subject area and media.

Subject Area, Media, and Pacing	SEQUENCE	
Science Slide-Tape Presentation Group Paced	Single-concept sequence ⟷	Multiple-concept sequence
Language Arts Self-Instructional Program Individually Paced	Single-concept sequence ⟷	Multiple-concept sequence

Fig. 7. Experimental plan of the study.

Subjects. Fifth-grade students from four Pittsburgh public schools served as subjects. The material in the science presentation was administered to students from two classes in each of two schools (N = 94). Students from both schools were arranged in a single ranking by Kulhman-Anderson IQ test scores and matched pairs of students were identified. A member of each pair was randomly assigned to one of the experimental conditions, i.e., either to the group that received the multiple-concept sequence or the group that received the single-concept sequence. This procedure assured that both groups would be matched in IQ. Since the procedure permitted a student from any class and any school to be assigned to either experimental group, school and class were not systematic variables in the study. A similar procedure was used for assigning students to the two experimental groups for the language arts program. However, only students from two classes, one in each school, participated in the language arts program (N = 50).

Administration of the science slide-tape presentation. Students assigned to each sequencing condition met in a room equipped with a 35mm slide projector, screen, and tape recorder. All presentations were given in the morning during the first class periods for about 1½ hours per day for five consecutive days. On the first day, the students took the criterion test as a pretest. During days two, three, and four, the science slide-tape presentation was administered on a group basis. The 35mm slides, which illustrated the concepts discussed in the tape-recorded narration and cued student responses, were projected on a screen at the front of the classroom. A tape-recorded narration was synchronized with the slides. A written response was required for each slide and its accompanying narration. Confirmation of a correct response was provided by additional narration on the tape. Although each student made his own response to each slide, the presentation was paced for the group. Most students appeared to have sufficient time to complete each response. Instruction was completed on the fourth day. The criterion test was administered as a posttest on the fifth day. It was given again as a rentention measure one week after the posttest.

Administration of the language arts self-instructional program. Students assigned to each sequencing condition worked the program in their own classrooms. Since the program provided individualized instruction, the two versions of the program could be administered in the same room simply by giving different students different versions of the materials. The programs were arranged so that each item appeared on a separate page of a booklet with its correct answer on the following page.

The criterion test was administered as a pretest on the first day. Students began the program on the second day and worked it

at their own individual rates for the next three days until they had finished it. All students completed the program in the available time. As soon as a student completed the program, he took the criterion test as a posttest. One week after the last posttest, the test was readministered as a retention measure.

Results

Since matched pairs of students were assigned to the two sequencing conditions, the results were analyzed by *t* tests for the difference between members of the pairs. Analysis of pretest scores indicated there were no significant differences between students assigned to the two sequencing conditions prior to the experiment.

Comparisons of the two sequencing strategies for the science slide-tape lessons are shown in Table 2. The students receiving the multiple-concept sequence performed significantly better than the students receiving the single-concept sequence. This was true both on the posttest and on the one-week retention test. The mean for the multiple-concept group was about 14% higher than the mean for the single-concept group, both on the posttest and on the retention test measures.

The effects of the two sequencing conditions in the language arts program are shown in Table 3. None of the comparisons between sequencing strategies for the language arts program was significant. However, Table 2 shows that the trends in group means for the language arts program are similar to those for the science program: all comparisons favor the multiple-concept sequence although the difference is not statistically reliable and quite small, only 4%.

The criterion test was constructed to measure the differential effect of each sequence. In Part I of each test, students were required to recognize, identify, or discriminate among major concepts. In Part II of the tests, they were required to construct or use each concept separately by recalling everything they could about it. Part I of the tests might be considered the more appropriate test for the multiple-concept sequence and Part II more appropriate for the single-concept sequence.

Separate analysis of test parts, however, simply mirrored the overall test results. Students in the multiple-concept groups scored significantly higher on both the discrimination and the concept-construction sections of the science posttests (Table 4). There were no significant differences between test parts for the language arts program, although all means favor the multiple concept group.

The sequencing strategies did not produce an apparent difference in working time for students on the self-paced programs. The sentence portion of the language arts program required approximately the same mean times in both sequencing strategies (single concept mean: 67 minutes; multiple concept mean: 69 minutes).

TABLE 2

Criterion Test Scores for Science Slide-Tape Lessons

	Sequence	Mean % Correct	Mean Raw Score	SD	$\bar{D}$	$s_{\bar{x}_1-\bar{x}_2}$	t	df	p
POSTTEST	Multiple-Concept	66.2%	70.8	14.1	8.7	3.0	2.90	45	<.01
	Single-Concept	58.0%	62.1	16.5					
RETENTION TEST	Multiple-Concept	65.1%	69.7	16.2	8.7	2.8	3.15	45	<.01
	Single-Concept	56.9%	60.9	17.6					

TABLE 3

Criterion Test Scores for Language Arts Program

	Sequence	Mean % Correct	Mean Raw Score	SD	$\bar{D}$	$s_{\bar{x}_1-\bar{x}_2}$	t	df	p
POSTTEST	Multiple-Concept	72.2%	43.3	7.9	1.8	1.28	1.41	24	.20>p>.10 n.s.
	Single-Concept	69.2%	41.5	7.0					
RETENTION TEST	Multiple-Concept	73.3%	44.0	7.2	1.1	1.2	.96	24	.40>p>.30 n.s.
	Single-Concept	71.3%	42.8	5.4					

TABLE 4

Posttest Scores for Parts I and II of the Science Criterion Test

TEST PART	SEQUENCE	MEAN	$\bar{D}$	$s_{\bar{x}_1-\bar{x}_2}$	t	df	p
PART I DISCRIMINATION	Multiple Concept	53.3	5.8	1.8	3.16	45	<.01
	Single Concept	47.5					
PART II CONCEPT CONSTRUCTION	Multiple Concept	17.5	2.8	.99	2.83	45	<.01
	Single Concept	14.6					

In summary, all comparisons of student performance favored the groups receiving the multiple-concept sequence. Although the differences between sequences were reliable at the conventional levels of statistical significance for the science slide-tape presentation, the differences were not significant for the language arts program. The size of the difference between means for most comparisons ranged from 4%-14%, with the multiple-concept sequence always producing the higher group mean.

Discussion

The results of the study indicate that a multiple-concept sequence is more effective than a single-concept sequence for teaching multiple discrimination tasks. Although the statistical reliability of this finding varied for the different lessons, the multiple-concept sequence tended to produce better student performance both immediately after training and on retention tests. The trends are consistent for different subject matters (the pilot program, the science lessons and the language arts lessons), different media (programmed text and slide-tape presentation), and different pacing conditions (fixed pace and individual pace).

The multiple-concept strategy produced a 20% higher mean score for the pilot program, 14% higher for the science slide-tape presentation, and 4% higher for the language arts programmed text.

A post-hoc analysis of these results indicates that the difference in the effectiveness of the multiple-concept sequence for the various lessons can be explained in terms of the extent to which each lesson required students to learn a new multiple discrimination task. The subject matter for the pilot program was deliberately created to have the characteristics of this type of task. Therefore, students could not make appropriate responses before training, but after training they were able to discriminate between very similar stimuli and make differentiated responses to them. This is the essential characteristic of a multiple discrimination task.

When this characteristic was deliberately built into the learning task in the pilot program, the sequencing variable had its greatest effect. As the real learning tasks deviated from this ideal, the sequence of instruction seems to have become a less important variable.

Although animal taxonomy is basically a multiple discrimination task, some fifth-grade students already knew some of the relevant discriminations before they began the lesson. For example, at the beginning of training, some students in each group could already reliably identify animals in three classes--birds, fish, and mammals. They had difficulty only in discriminating reptiles and amphibians from each other and from fish and mammals. Since some students already knew some of the required discriminations, the science lesson was a less clear-cut example of a new multiple discrimination task than the pilot program.

A similar factor seems to have affected the language arts program to an even greater degree. Students were able to discriminate fairly well among sentence fragments, run-on sentences, and correct sentences before training. Pretest scores seem to confirm this general trend. Although there were no significant differences between the multiple-concept and single-concept groups on any pretest, there were differences in pretest scores between lessons. It can be assumed the pretest score for the pilot program would have been about zero, since the program taught an artificial, contrived task. The median pretest score for the science presentation for both the single-concept and the multiple-concept groups combined was 28%; the median score for the language arts pretest was 56%. To some extent the pretest scores represent a measure of the amount of discrimination training required to learn the task. As pretraining proficiency of the discrimination increased, as evidenced by the pretest scores, the effect of the sequencing variable seems to have become less important.

Sequencing is often discussed as a primary learning variable. It is probably more usefully viewed as a method of setting up other conditions of learning. In the present study, a number of these conditions were changed by resequencing the instructional items. Although the study did not attempt to isolate these variables or measure the relative effect of each, it is possible to relate the two sequencing strategies to their effect on other conditions of learning in order to explain, after-the-fact, why the multiple-concept sequence was more effective.

First, the two sequences produced different response probabilities for the same instructional items. In the single-concept sequence, the population of responses called for in a given section is relatively small. The student can probably predict what responses he will be asked to give on the next item, even before he reads the item because adjacent items will concern the same concept. Thus, in the single-concept sequence, one item cues the next item because both concern the same concept. Without reading ahead, the student probably knows that the response he will give in the next item is one of a small number of possible responses about the concept being taught. In the multiple-concept sequence, the population of responses is considerably larger. It is probably not as easy for the student to predict what the next response will be because it can concern any of the major concepts. In this way, inter-item cuing is severely reduced in the multiple-concept sequence and each item must be answered independently. Although the stimulus and response elements of both sequences were physically identical, the sequencing strategies may well have arranged the instructional items in such a way that preceding questions and answers provided highly cued practice in the single-concept sequence and very little cuing in the multiple-concept version.

A second condition of learning that may vary with sequencing is the relevance of required responses. Studies have shown that students learn more when they are required to make relevant responses, i.e., the responses called for on a criterion test: Holland (8) and Eigen and Margulies (3). In the present study, students had to make the same overt responses in both sequences. However, the covert response requirements were probably quite different. For the multiple-concept sequence, the overt response almost always required the student to make a preceding, mediating, covert discrimination. For example, a student not only had to write the class of an animal (the overt response) but he also had to consider all classes of animals and choose the appropriate one before he could make his overt response. In the single-concept sequence, however, he could classify an animal simply from his knowledge that a long string of preceding items had concerned the same class of animals. To the extent that making discriminations is part of the criterion performance, then to that extent the multiple-concept version should be superior to the single-concept version. In retrospect, this type of covert response seems relatively unimportant in the language arts program, since classifying a sentence error is probably not a required, or even useful, step in correcting the error.

A third factor that may be affected by sequencing strategy is the student's knowledge of what he is supposed to learn. In the present study, an effort was made to control for a simple overview effect by including an introductory section before both sequences. In these overviews, students were asked to respond to the whole range of concepts and to describe what they would learn in the lesson. In spite of the fact that the overview was included in the single-concept sequence, it was not an effective substitute for the discrimination practice included in the multiple-concept sequence. Thus it would seem that a traditional overview or introduction is not an effective substitute for the appropriate sequencing strategy in teaching a multiple discrimination task.

Finally, the sequencing strategies may have changed the review conditions in a lesson. The multiple-concept sequence ended with a review of all concepts; the single-concept sequence ended only with a review of the final concept. One quite reasonable alternative to the multiple-concept sequence would be to use a single-concept sequence followed by a multiple-concept review. There are no data from the present study to suggest how effective this combined strategy would be, but there are data that suggest it would be less efficient than the multiple-concept sequence alone. The fixed pace science presentation required the same amount of time in the single and multiple-concept versions. If a review unit were added to the end of the single-concept sequence, it would make it longer than the multiple-concept sequence. Even in the

self paced, language arts programs, there were no differences in the mean times required for students to complete the multiple-concept and single-concept versions. Thus it seems likely that a combined single-concept strategy with a multiple-concept review would require more time and would therefore be less efficient than a multiple-concept sequence alone.

In summary, the effectiveness of the multiple-concept sequence can be explained in terms of its effects on several conditions of learning: lower response predictability; less highly cued practice; more relevant responding; more knowledge of objectives; and more appropriate review conditions.

Conclusions and Recommendations

What conclusions can be drawn from the study? First, that the sequence of instruction can, in fact, affect how much students learn. Although this conclusion seems to be intuitively obvious, there are many studies in which sequencing was not found to affect learning (cf. Chapter 1). The key difference between this study and earlier ones would seem to be the assumption that the sequence of instruction must be considered in relation to the type of behavior to be taught. Although this conclusion was not directly tested in the study, the results suggest that it is possible to identify optimum sequencing strategies for teaching different types of behavioral tasks. A second conclusion of the study is this: it is possible to recommend a specific sequencing strategy for teaching one type of behavior, multiple-discrimination behavior, with reasonable assurance that the sequence will improve the effectiveness of instruction.

The multiple-concept sequencing strategy is not always the most logical or obvious one, at least from the point of view of the expert writer or teacher. Although it establishes several important conditions for effective learning, the multiple-concept sequence seems to fragment the subject matter because it requires a teacher or writer to deal with several related concepts simultaneously rather than one at a time. The multiple-concept sequence is probably the more difficult strategy for instructors to use at first, since it is somewhat like juggling several balls at once rather than simply tossing one ball up and down. To use the strategy, the instructor must keep several concepts before his students, initially at a very easy level and then at gradually increasing levels of difficulty.

The study suggests two recommendations: (1) the study of other sequencing strategies for other types of behaviors, e.g., procedural chains, applications of complex principles to new examples, etc.; and (2) an implementation study designed to encourage instructors, media specialists and course writers to utilize the findings of the present study in preparing their own materials.

There have been several opportunities to present the results of the present study to instructors, media specialists, and course writers. In fact, the pilot program was evaluated with such a group participating in a programming workshop. The people in this workshop first took the pilot program. The results of the pilot study were discussed with the group and the multiple-concept sequencing strategy discussed in detail. The writers then had the opportunity to apply these findings to their own instructional programs. They seemed to see things quite differently when they

were taking the pilot program and when they were writing their own material. Those who took the single-concept version seemed to realize that they were learning a multiple-discrimination task: they often referred back to earlier items in the program, and thus resequencing the planned sequence by looking back to check on old information they found confusing in the light of new information. In the later class discussion, students in the single-concept group said that they had difficulty remembering how a new concept and its examples differed from a concept they had learned earlier. In spite of this, when they began to write their own material, they used a single-concept sequence to teach multiple-discrimination tasks. Apparently the single-concept sequence was so natural to them that they continued to write their own materials using it even when their objectives clearly indicated that they were trying to teach students to discriminate among several related concepts.

In order to disseminate the results of the study and affect the behavior of writers and media specialists, more seems to be needed than a narrative report of the procedures and results. Probably a brief training program would suffice. The training program would give writers an opportunity to identify multiple-discrimination tasks and to choose the appropriate sequence for teaching them. Both the objectives and sequences could be illustrated by examples from various content areas so that writers could learn to apply the strategy to their own instructional objectives. At the end of the program, the writers could practice writing a short sequence using the multiple-concept strategy with some relatively simple topic such as the use of there, their, and they're; to, two, or too; latitude and longitude; resistance, current, and power; etc. The complete program would probably require only an hour or two of a writer's time, but it appears to be necessary if the results of the study are to have any practical effect on instruction.

It may seem unrealistic to suggest that the results of the study are important enough to justify their own implementation program. They represent only a small portion of our knowledge about instructional technology and, as such, could best be taught as part of a general instructional technology program. Unlike some other instructional strategies, however, sequencing strategies can be implemented in many existing instructional situations. The strategy can be used not only in preparing lessons for programmed texts, films, and other new media, but also in normal classroom presentation, in the construction of practice exercises, and even in the choice of work problems for homework assignments. Thus, without radically changing the classroom structure, the strategy could be introduced in existing instructional settings.

The results of the study also confirm the suggestion that it is possible to evaluate sequencing strategies in relation to specific types of behavioral tasks. It would seem useful to investigate other sequencing strategies designed to teach other types of behaviors. An obvious choice for future study is another operant conditioning strategy described by Gilbert (6) that involves the teaching of behavioral chains. The traiitional strategy is to teach the chain the way it is performed--from first step to last. Gilbert has specified a backward chaining procedure that is quite similar to the procedure used to teach animals to perform this type of behavior.

Comparisons of these two strategies have been made by Slack (14) who found the backward chaining procedure to be more effective, and by Johnson and Senter (9) who found the forward chaining procedure to be more effective. It is not clear if the different results reported in these studies are functions of different types of tasks, different task complexities, different methods of presentation, or some other variable. It would seem reasonable to use the design of the present study and build several lessons of reasonable length to test the applicability of the strategies and to arrive at general guidelines for sequencing procedural chains.

Summary

Problem

All new instructional media share a common characteristic: materials prepared in these media have fixed instructional sequences. Once a program, film, or tape is prepared, it preserves its sequence and presents it again and again to new groups of students. The sequence of instruction is usually determined intuitively or, in programmed instruction, by trial and error during tryout and revision. In spite of the apparent importance of sequencing strategies, there are few, if any, experimentally validated guidelines for choosing between alternate sequencing strategies in preparing instructional materials in new media.

Objectives

The objectives of the study were: (1) to evaluate two contrasting sequencing strategies for teaching multiple-discrimination tasks, and (2) to determine if these strategies give consistently different results when they are applied to different subject matters presented in different media.

Procedure

Two strategies that can be applied to many different subject matters and to different media were distinguished. The multiple-concept strategy presents simple descriptions of several related concepts at the beginning of instruction. Increasingly complex material pertaining to these concepts is then gradually introduced. The single-concept strategy presents one concept at a time, proceeding from a simple description of the single concept to more complex descriptions of the same concept. After the concept has been presented in all its detail and complexity, a second concept is introduced, described in detail, and then a third concept is introduced, etc.

Two sets of instructional materials were prepared for fifth-grade students: science materials for presentation to groups at a fixed pace as slide-tape lessons, and language arts materials for individually paced presentation in programmed textbooks. Two sequences were prepared for each lesson following the strategies described above. Each version contained the same instructional items and required the same student responses; only the sequence of items was changed.

Results

The multiple-concept sequence produced consistently better student performance. The differences between groups on both the posttests and retention tests were significant at the .01 level for the science lessons, but not significant for the language arts lessons. However, all trends favored the multiple-concept sequencing strategy.

Conclusions

A sequencing strategy for teaching multiple discrimination tasks was evaluated and found to be better than another commonly used strategy. The strategy is described in general terms so that it can be applied to other instructional materials besides those used in the study. The results suggest that it is possible to identify sequencing strategies for teaching specific types of behavioral tasks and that these strategies are applicable to different subject matter and different media.

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APPENDIX A

ELEMENTS OF THE CONCEPTS

MAJOR CONCEPTS

	Reproduction	Breathing	Covering	Temperature	Examples
FISH	lay soft eggs in water	breathe with gills	covered with moist scales	changes with environment	eel, seahorse
AMPHIBIAN	lay soft eggs in water	breathe with gills, then with lungs	covered with moist skin	changes with environment	newt
REPTILE	lays hard shelled eggs on land	breathes with lungs	covered with dry scales	changes with environment	pterodactl
BIRD	lays hard shelled eggs on land	breathes with lungs	covered with feathers	constant	penguin
MAMMAL	young are born alive	breathes with lungs	covered with hair or fur	constant	bat, porpoise

A-2. Matrix illustrating the concepts taught in the animal portion of the slide-tape science lesson.

ELEMENTS OF THE CONCEPTS

MAJOR CONCEPTS	Name of foot	Common bird	Use of foot or environment	Description of beak	Main food
SWIMMING BIRD (water plant eater)	swimming	duck	swimming, lives near water	wide, flat and rounded	water plants
SWIMMING BIRD (fish eater)	swimming	loon	swimming, lives near water	long, strong and pointed	fish
PERCHING BIRD (seed eater)	perching	red bird	perching, lives on limbs or branches	short and stubby	seeds
PERCHING BIRD (insect eater)	perching	robin	perching, lives on limbs or branches	long and pointed	insects
WALKING BIRD (seed eater)	walking	chicken	walking, lives on ground	short and stubby	seeds
WALKING BIRD (insect eater)	walking	sandpiper	walking, lives on ground	long and pointed	insects
GRASPING BIRD	grasping	eagle	catching and carrying food	hooked	meat
CLIMBING BIRD	climbing	woodpecker	climbing trunks of trees	long and pointed	insects

A-3. Matrix illustrating the concepts taught in the bird portion of the slide-tape science lesson.

ELEMENTS OF THE CONCEPTS

MAJOR CONCEPTS	Recognizing meaning in sentences	Placement of accent	Rhyme for word	Synonym	Use word in own sentences	Correct spelling
DEBRIS	ex. "trash in empty lot"	second syllable	free	rubbish or litter		debris
INITIAL	ex. "first number"	second syllable	official	first		initial
HYPOCRITE	ex. "two-faced person"	first syllable	knit	two-faced		hypocrite
OBSOLETE	ex. "model "T" car"	third syllable	meet	old-fashioned		obsolete
PERSEVERANCE	ex. "high hill to climb"	third syllable	clearance	keeping going		perseverance

A-4. Matrix illustrating the concepts taught in the vocabulary portion of the programmed text language arts lesson.

ELEMENTS OF THE CONCEPTS

MAJOR CONCEPTS	Identify poor sentences	Identify type of error	Identify and correct poor sentence	Identify poor sentence in paragraph and correct it
FRAGMENT TYPE 1 (no subject)	Check if sentence is OK or bad	Fragment	Add subject	Add subject
FRAGMENT TYPE 2 (no verb)	Check if sentence is OK or bad	Fragment	Add verb	Add verb
FRAGMENT TYPE 3 (phrase)	Check if sentence is OK or bad	Fragment	Add verb or subject	Add verb or subject
RUN-ON TYPE 1 (2 sentences connected by "and" or "and there")	Check if sentence is OK or bad	Run-on	Divide into separate sentences	Divide into separate sentences
RUN-ON TYPE 2 (2 sentences connected by commas)	Check if sentence is OK or bad	Run-on	Divide into separate sentences	Divide into separate sentences
RUN-ON TYPE 3 (2 sentences; no punctuation)	Check if sentence is OK or bad	Run-on	Divide into separate sentences	Divide into separate sentences

A-5. Matrix illustrating the concepts taught in the sentence portion of the programmed text language arts lesson.

APPENDIX B

A N I M A L S

Part I

Name _____

School _____

Date _____

Here are some questions about animals. Answer all the questions you can. If you do not know an answer to a question, leave it blank. Work as quickly as you can, and do not spend too much time on any one question.

NOTE: The tests are reduced approximately 35% from their original size.

1. What do all invertebrates have in common?_____

2. What do all vertebrates have in common?_____

3. Circle the animal that lays soft eggs in water.

4. Circle the animal that lays eggs with hard shells.

5. Circle the animal that lays soft, jelly-like eggs.

6. Circle the animal that has young that are born alive.

7. Circle the animal whose inside body temperature depends on the outside temperature.

8. Circle the animal whose inside body temperature does not depend on the outside temperature.

9. How does this animal breathe early in its life?_____

How does it breathe later in its life?_____

10. How does this animal breathe early in its life?_____

How does it breathe later in its life?_____

11. How does this animal breathe early in its life? _____

How does it breathe later in its life?_____

12. What is this animal's covering? _____

13. What is this animal's covering? _____

14. What is this animal's covering?_____

15. How does this animal reproduce or have its young? _____

16. List the five classes of vertebrates.

_____

_____

_____

_____

_____

17. Which classes of vertebrates are covered with scales?

_____

_____

18. Which classes of vertebrates lay hard-shelled eggs?

_____

_____

19. Which classes breathe air all their lives with lungs?

_____

_____

_____

20. Which is the only class that has young that are born alive?

_____

21. Which classes have inside body temperatures that depend on the outside temperature? In other words, animals in which class have inside body temperatures that change as they move from colder to warmer places?

_____

_____

_____

22. Write the class of the animals:

snake_____

toad_____

salamander_____

alligator_____

eel_____

porpoise_____

penguin_____

turtle_____

23. The inside body temperature of this sea lion is about 70°. The temperature of the water is 50°. After the sea lion goes into the water and stays there for a while, what will his inside body temperature be?_____

24. The inside body temperature of this frog is about 60°. The temperature of the water is 45°. After the frog jumps into the water and stays there for a while, what will its inside body temperature be?

_____

A N I M A L S

Part II

Name_____

School_____

Date_____

Here are some questions about animals. Answer all the questions you can. If you do not know an answer to a question, leave it blank. Work as quickly as you can, and do not spend too much time on any one question.

25. Write everything you know about fish.

26. Write everything you know about amphibians.

27. Write everything you know about reptiles.

28. Write everything you know about birds.

29. Write everything you know about mammals.

B I R D S

Part I

Name _____

School _____

Date _____

Here are some questions about birds. Answer all the questions you can. If you do not know an answer to a question, leave it blank. Work as quickly as you can, and do not spend too much time on any one question.

1. This is a drawing of a bird's foot. This type of foot is well made for _____.

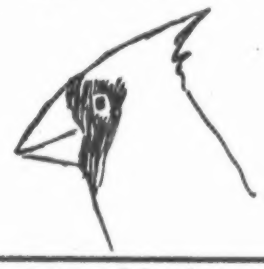
2. This is a drawing of another type of bird's foot. This type of foot is well made for _____.

3. This type of foot is well made for _____.

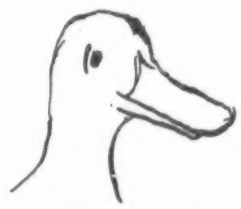
4. This type of foot is well made for _____.

5. This type of foot is well made for _____.

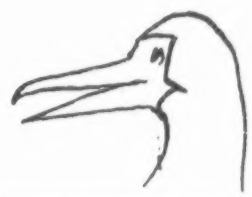
6. Birds with this type of beak usually eat _____.



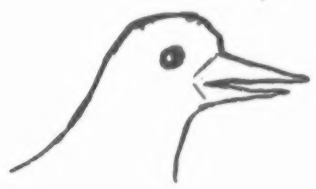
7. Birds with this type of beak usually eat _____.



8. Birds with this type of beak that live <u>near</u> <u>water</u> usually eat _____.



9. <u>Land</u> birds with this type of beak usually eat _____.



10. Birds with this type of beak usually eat _____.

11. Where does this bird hunt his food? _____

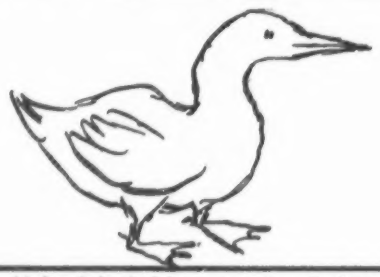
_____

What does it eat? _____

12. Where does this bird live? _____

13. Where does this bird live? _____

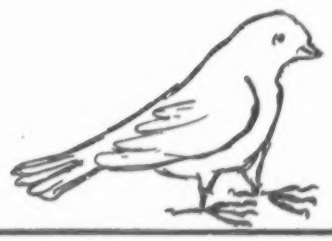
What does it eat? _____



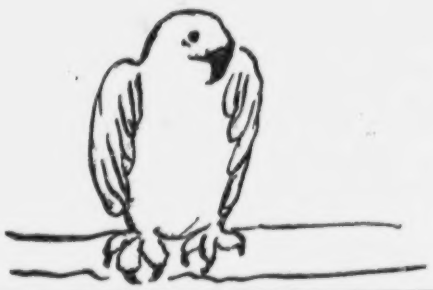
14. Where does this bird live most of the time? _____

_____

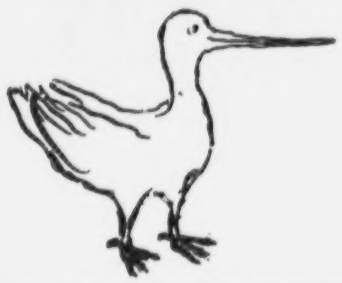
What does it eat? _____



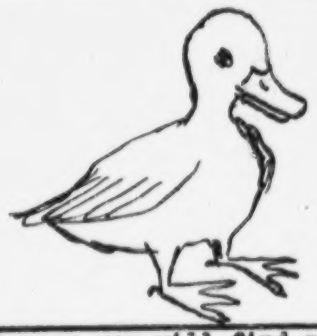
15. What does this bird eat? _____



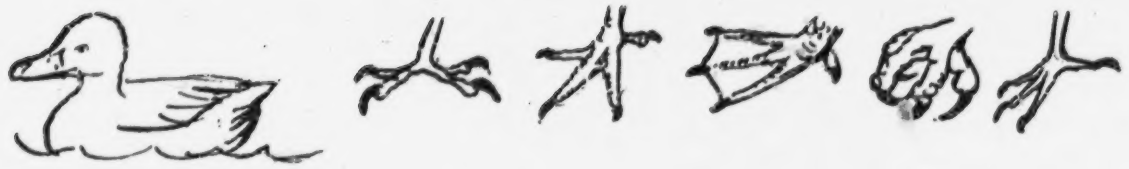
16. What does this bird eat? _____

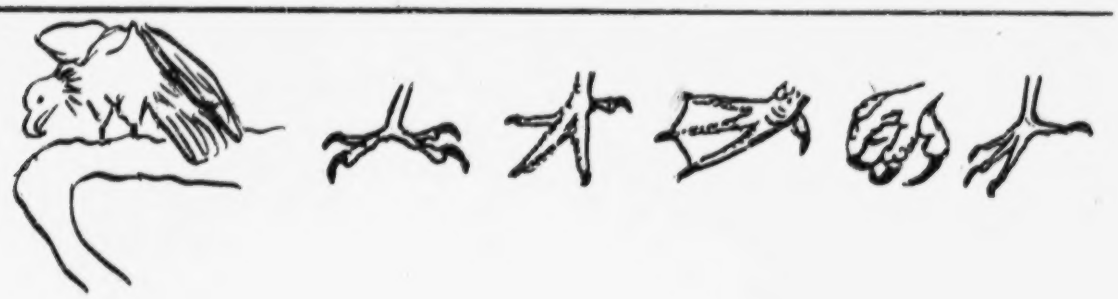


17. What does this bird eat? _____



18. On the next page you will find pictures of five different birds. Next to each bird are different kinds of feet that it might have. Draw a circle around the kind of feet that you would expect each kind of bird to have.





B I R D S

Part II

Name _____

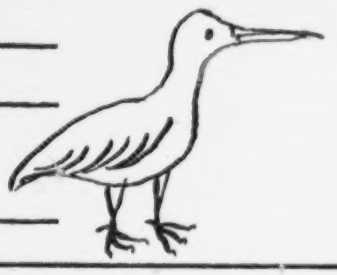
School _____

Date _____

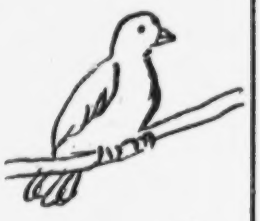
Here are some questions about birds. Answer all the questions you can. If you do not know an answer to a question, leave it blank. Work as quickly as you can, and do not spend too much time on any one question.

19. Write everything you know about this bird.

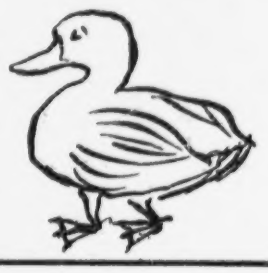
20. Write everything you know about this bird.



21. Write everything you know about this bird.



22. Write everything you know about this bird.



23. Write everything you know about this bird.

V O C A B U L A R Y

Part I

Name _____

School _____

Date _____

List the five new words you have learned:

1. _____

2. _____

3. _____

4. _____

5. _____

V O C A B U L A R Y

Part II

Name _____

School _____

Date _____

Here are some questions about words. Answer all the questions you can. If you do not know an answer to a question, check "I don't know". Work as quickly as you can and do not spend too much time on any one question.

1. Initial rhymes with

_____ dial
_____ hull
_____ pail
_____ I don't know

2. Hypocrite rhymes with

_____ fight
_____ lit
_____ mighty
_____ I don't know

3. Debris rhymes with

_____ me
_____ kiss
_____ seize
_____ I don't know

4. Obsolete rhymes with

_____ wait
_____ let
_____ seat
_____ I don't know

5. Perseverance rhymes with

_____ half-inch
_____ disappearance
_____ fence
_____ I don't know

6. Debris means the same as

_____ sorrow
_____ rubbish
_____ debts
_____ I don't know

7. Perseverance means the same as

_____ keeping quiet
_____ keeping going
_____ keeping still
_____ I don't know

8. Initial means the same as

_____ once
_____ first
_____ only
_____ I don't know

9. Hypocrite means the same as

_____ two-faced
_____ old fashioned
_____ hyponotic
_____ I don't know

10. Obsolete means the same as

_____ over done
_____ most important
_____ old fashioned
_____ I don't know

11. Use the word debris in a sentence.

_____

_____

_____

12. Use the word initial in a sentence.

_____

_____

_____

13. Use the word perseverance in a sentence.

_____

_____

_____

14. Use the word hypocrite in a sentence.

_____

_____

_____

15. Use the word obsolete in a sentence.

_____

_____

_____

Sentences

Part I

Name _____

School _____

Date _____

Here are some questions about sentences. Answer all the questions you can. If you do not know the answer to a question, leave it blank. Work as quickly as you can, and do not spend too much time on any one question.

1.

Read each item below. Circle "part" if it is a sentence part; circle "run-on" if it is a run-on sentence; circle "OK" if the sentence is correct. Study the example: the sentence is correct, so OK has been circled.

part

run-on

(OK)

1. Sally is in the house.

---

part

run-on

OK

2. The cat caught a mouse.

---

part

run-on

OK

3. Peter Pan is a book. By J. M. Barrie.

---

part

run-on

OK

4. When the sun rose the man woke up and then he got dressed quickly and then he hurried off to work at the grocery store.

---

part

run-on

OK

5. Many children love fairy tales.

---

part

run-on

OK

6. The snow began to fall on Sunday afternoon by Monday there was nine inches of snow on the ground.

---

part

run-on

OK

7. Ran quickly out of the movie theatre.

---

part

run-on

OK

8. After we read the story the teacher asked questions, Johnny didn't know the answers.

---

part

run-on

OK

9. Before she read to the end of the book she fell asleep.

---

part

run-on

OK

10. The man in an old station wagon.

---

part

run-on

OK

11. Jane in the automobile.

Study how to make corrections on sentences. Then go to the next page and correct any poor sentences you find.

You may correct sentences by crossing out words or punctuation.

Example: *I went to the store, in my car.*

You can also add words or punctuation.

Example: *The cow jumped over the moon.*

To change a capital letter to a small letter, draw a line through the capital letter and write the small letter above it.

Example: *Mary borrowed a book from the library.*

To change a small letter to a capital letter, draw a line through it and write the capital letter above it.

Example: *Her name is Alice.*

Read each item. Correct any poor sentence. Check back to the previous page to see how to correct these sentences

1. As I started to walk home. The sun came out.
2. I chased the butterfly for miles and miles and it kept getting away from me no matter how fast I ran.
3. Threw the ball as hard as he could.
4. The old woman lived in a very old house.
5. The two boys went to the store to buy candy all they had was a nickel for each of them.
6. The sun shone brightly for a few minutes, suddenly it vanished behind a cloud.
7. They promised not to make any noise. For the rest of the afternoon.
8. The dog ran after a rabbit and then the rabbit started to run much faster than the dog and the dog stopped and rested by the side of the road.
9. Fell and hurt herself on the slippery ice.
10. On their summer vacation the Jackson family passed through Ohio, West Virginia, Illinois and Michigan.
11. John on his way to the movies.
12. They met the train at the station no one got off.
13. Leap year occurs every four years.
14. Mary spilled ink on her new dress, her mother immediately soaked it in cold water.
15. The dog after the stick.
16. Since each state has two senators, the United States Senate is comprised of one hundred members.

Correct any bad sentences you find in this paragraph.

It was Ralph's first day at the new school. The first period, the teacher called on him to read and then he couldn't find his place in the book. The worst moment was when the other children laughed at him. Because he made a mistake. Ralph hoped the second day of school would be better.

Correct any bad sentences you find in this paragraph.

Most people don't realize how important policemen are to our safety. They protect us from criminals. Keep us safe in our homes. Some policemen are called plain-clothesmen they do not wear uniforms. We should consider the police force as our friends.

Sentences

Part II

Name_____

School_____

Date_____

Here are some questions about sentences. Answer all the questions you can. If you do not know the answer to a question, leave it blank. Work as quickly as you can, and do not spend too much time on any one question.

1.

Correct these run-on sentences:

1. Mary Ann lived by the ocean in New Jersey and she was very unhappy when her parents told her she would have to go to school in Pennsylvania.
2. The best pets to have in an apartment in the city are tropical fish they are no trouble at all to take care of.
3. George Washington's birthday is February 22, he has been called the "Father of his Country."
4. The star of the football team carried the ball for a touchdown and then all the fans began to cheer.
5. The car skidded across the highway into a fence none of the passengers were hurt.

Correct these sentence parts:

1. Mrs. Lewis lost her purse. On the way to church.
2. Told her daughter to hurry home after school.
3. Shirley in the school chair.
4. After the rain. A rainbow appeared in the sky.
5. Lost her glass slipper at the ball.

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15. ABSTRACT *(250 words max.)*

The objectives of the study were to evaluate two contrasting strategies for teaching multiple discrimination tasks and to determine if these strategies give consistently different results when applied to different subject matters in different media.

Two strategies were distinguished: (1) the multiple-concept strategy, which presents simple descriptions of several related concepts at the beginning of instruction and gradually introduces increasingly complex material pertaining to all these concepts; and (2) the single-concept strategy, which proceeds from a simple description of a single concept to more complex descriptions of the same concept, then a second concept is introduced, described in detail, etc.

Two sets of instructional materials were prepared for fifth-grade students: science materials for presentation to groups at a fixed pace as slide-tape lessons, and language arts materials for individually paced presentation in programmed textbooks. Two sequences were prepared for each lesson following the strategies described above. Each version contained the same instructional items and required the same student responses; only the sequence of items was changed.

The multiple-concept sequence produced consistently better student performance. The differences between groups on both the posttest and retention tests were significant at the .01 level for the science lessons, but not significant for the language arts lessons. However, all trends favored the multiple-concept sequencing strategy.

16. RETRIEVAL TERMS *(Continue on reverse)*

	Sequencing Multiple discrimination task Programmed instruction Audio-visual instruction Slide-tape presentations Elementary education (5th grade)		Science lessons Language arts lessons Instructional strategies

17. IDENTIFIERS

Figure 3. ERIC Document Resume